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PATENT ABSTRACTS OF JAPAN

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(71)Applicant : TOSHIBA CORP

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(72)Inventor : MIURA HIROSHI

TAMAGAWA TORU

TERAI KIYOHISA

TAKAHASHI MASAO

IKUTA SAKAE

NIWA KEIKO

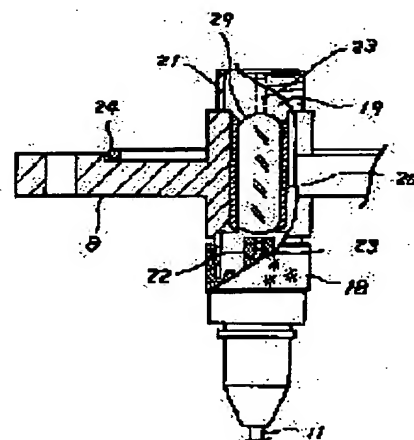
SAITO MINORU

(54) OPTICAL CURRENT TRANSFORMER AND ITS MANUFACTURE

(57)Abstract:

PURPOSE: To measure an electric current with high accuracy even under a bad condition by airtightly inserting a rod lens into the through hole of an airtight optical connector so that light can be introduced to an arithmetic and output section.

CONSTITUTION: A rod lens 29 made of low-strain glass is inserted into a through hole 19 and fixed with an adhesive 20. Since the low-strain glass which is optical glass produced by eliminating residual stresses from the inside of the glass by performing annealing, etc., is used for the lens 29, the occurrence of the double refraction of light can be suppressed to an extremely low level. Since the rod lens 29, in addition, is formed by uniting a lens and glass rod in one body, excellent optical coupling can be obtained when the optical axis of the lens 29 is aligned with that of a capillary section 22, because light is condensed to an optical fiber 23. In addition, the lens 29 has a high vibration



resistance and impact resistance. When a silicone rubber adhesive having a Young's modulus of 0.05-100 kg/mm² is used as the sticking means between the lens 29 and connector 8, the accuracy of an optical current transformer can be improved further, because the impact, vibration, thermal stress, etc., impressed upon the transformer are absorbed by the elasticity of the adhesive.

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CLAIMS

[Claim(s)]

[Claim 1] the energization arranged in the pressure septum by which the insulating medium was enclosed -- in order to measure the energization current of a conductor -- said energization -- a conductor -- in a periphery enclosure with the optical fiber by which winding arrangement was carried out The optical airtight connector which is airtightly attached in opening prepared in said pressure septum in order to derive to the operation output section which calculates said energization current which has arranged the light which carries out light transmission of this optical fiber to said pressure septum exterior, and has a through tube inside, The optical current transformer which insertion arrangement of the rod lens is carried out airtightly at said through tube of said optical airtight connector, and is characterized by drawing said light to said operation output section in a preparation ***** current transformer.

[Claim 2] the energization arranged in the pressure septum by which the insulating medium was enclosed -- in order to measure the energization current of a conductor -- said energization -- a conductor -- in a periphery enclosure with the optical fiber by which winding arrangement was carried out The optical airtight connector which is airtightly attached in opening prepared in said pressure septum in order to derive to the operation output section which calculates said energization current which has arranged the light which carries out light transmission of this optical fiber to said pressure septum exterior, and has a through tube inside, In a preparation ***** current transformer, an opto elastic constant to said through tube of said optical airtight connector Optical current transformer which insertion arrangement of the optical fiber below $1.0 \times 10^{-9} \text{cm}^2 / \text{kg}$ is carried out airtightly, and is characterized by drawing said light to said operation output section.

[Claim 3] The manufacture approach of the optical current transformer characterized by inserting this sheath in the through tube formed in the optical airtight connector, and carrying out adhesion immobilization of this after inserting an optical fiber in these through tubes of the sheath in which two or more through tubes were formed and carrying out adhesion immobilization of this, in case said optical airtight connector is made to penetrate two or more optical fibers and adhesion immobilization is carried out.

[Claim 4] as the adhesion means in the through tube of said optical airtight connector -- Young's modulus $0.05 - 100 \text{kg/mm}^2$ it is -- optical current transformer according to claim 1 to 3 characterized by using the silicone rubber which covered the outside surface by protection material.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Industrial Application] This invention relates to the optical current transformer which improved to the optical airtight connector for making a pressure septum penetrate especially an optical fiber about the so-called optical current transformer which can measure a current value using light, and its manufacture approach.

[0002]

[Description of the Prior Art] It considers as a sensor, the amperometry equipment for electric power system, i.e., the optical current transformer, using light, and it carries out **** contiguity, puts a block or optical fiber of lead glass or a quartz on a conductor, passes the light of the linearly polarized light, and makes it the principle to measure the angle of rotation of the Faraday effect produced by the field generated according to the measured current which flows to a conductor.

[0003] What used the optical fiber as the sensor as an example among the conventional optical current transformers is shown in drawing 4. The sensor 4 using an optical fiber is arranged so that a conductor 2 may be surrounded inside the GIS tank 1 which is a pressure septum. A sensor 4 is fixed to the maintenance material 5, and further, the maintenance material 5 insulates from touch-down potential with an insulating material 6, and is attached.

[0004] Moreover, transfer of the light of the optical current transformer of this structure is explained with reference to drawing 5. That is, after the light which emitted the light source of a light emitting diode 14 in the photo-electric-conversion section 9 passes an optical fiber 11, it is made into the linearly polarized light which polarized with the polarizer 12, carries out incidence to a sensor 4, obtains the fixed angle of rotation by the Faraday effect by passing the field generated around a conductor 2, and outgoing radiation is carried out to an analyzer 13, and it reaches a photodiode 15 after passing an optical fiber 11 again. Here, a condenser lens 17 is for serving to extract the flux of light of the light which is attached in the both ends of an optical fiber 11, respectively, and passes through the inside of an optical fiber. Furthermore, the airtight connector 8 through an optical connector 18 is connected to an optical fiber 11, an airtight is maintained, and the internal and external gas pressure difference of the GIS tank 1 is coped with. Furthermore, the light emitting diode 14 and the photodiode 15 which constitute the photo-electric-conversion section 9 are connected to the operation output section 10, respectively, and data processing is made.

[0005]

[Problem(s) to be Solved by the Invention] As for the optical fiber used for the optical airtight connector 8, it is desirable that it is accurate so that information on light may not be disturbed. However, although amorphous solid-states like the glass generally used as Faraday effect material are directions [target / optical], if stress is applied from the exterior, it will become an anisotropy optically and a birefringence will be caused. Moreover, since a coefficient of thermal expansion generally differs from other matter when glass is being firmly fixed to other matter, the thermal stress inside the glass generated by the temperature change also causes a birefringence. The starting birefringence becomes the cause of

worsening precision.

[0006] The detail of the optical airtight connector 8 is explained with reference to drawing 6. Since the adhesion closure of the optical fiber etc. is embedded and carried out, with the thermal stress generated inside by the gas pressure difference of GIS tank inside and outside, and the temperature change even if it can pass the usual light, the birefringence of a propagation path becomes large, the propagation precision of the linearly polarized light for measurement falls, and the passage part 19 of light also becomes the cause by which an optical-axis gap of an optical connector bond part occurs, further. On the other hand, in a busy condition, it becomes the cause by which an optical-axis gap of an optical connector bond part also generates this vibration, with vibration, and the error noise by change of the quantity of light is also caused.

[0007] Then, the purpose of this invention is offering the optical current transformer with which it prevents the accuracy of measurement falling under the effect of the stress by the gas pressure difference, thermal stress, vibration, etc., and vibration and a temperature change can measure a current with high degree of accuracy also under a large environment by improving to an optical airtight connector.

[0008]

[Means for Solving the Problem] In order to attain the above purpose, this invention as invention according to claim 1 the energization arranged in the pressure septum by which the insulating medium was enclosed -- in order to measure the energization current of a conductor -- said energization -- a conductor -- in a periphery enclosure with the optical fiber by which winding arrangement was carried out The optical airtight connector which is airtightly attached in opening prepared in said pressure septum in order to derive to the operation output section which calculates said energization current which has arranged the light which carries out light transmission of this optical fiber to said pressure septum exterior, and has a through tube inside, In a preparation ***** current transformer, the optical current transformer which insertion arrangement of the rod lens is carried out airtightly at said through tube of said optical airtight connector, and is characterized by drawing said light to said operation output section is offered.

[0009] moreover, the energization arranged as invention according to claim 2 in the pressure septum by which the insulating medium was enclosed -- in order to measure the energization current of a conductor -- said energization -- a conductor -- in a periphery enclosure with the optical fiber by which winding arrangement was carried out The optical airtight connector which is airtightly attached in opening prepared in said pressure septum in order to derive to the operation output section which calculates said energization current which has arranged the light which carries out light transmission of this optical fiber to said pressure septum exterior, and has a through tube inside, In a preparation ***** current transformer, an opto elastic constant to said through tube of said optical airtight connector Insertion arrangement of the optical fiber below $1.0 \times 10^{-9} \text{cm}^2 / \text{kg}$ is carried out airtightly, and the optical current transformer characterized by drawing said light to said operation output section is offered.

[0010] Moreover, in case said optical airtight connector is made to penetrate two or more optical fibers as invention according to claim 3 and adhesion immobilization is carried out, after inserting an optical fiber in these through tubes of the sheath in which two or more through tubes were formed and carrying out adhesion immobilization of this, the manufacture approach of the optical current transformer characterized by inserting this sheath in the through tube formed in the optical airtight connector, and carrying out adhesion immobilization of this is offered.

[0011] moreover -- as an adhesion means [in / as invention according to claim 4 / the through tube of said optical airtight connector] -- Young's modulus $0.05 - 100 \text{kg/mm}^2$ it is -- the optical current transformer according to claim 1. to 3 characterized by using the silicone rubber which covered the outside surface by protection material is offered.

[0012]

[Function] Under a configuration of starting, by having inserted low distorted glass etc. in the through tube formed in the optical airtight connector, and having carried out adhesion immobilization, generating and an optical-axis gap of a birefringence can be reduced, and the accuracy of measurement

can be raised. Moreover, since low distorted glass, etc. an optical airtight connector, and airtight immobilization of a between use silicone rubber as adhesives and they may absorb the stress which joins an adhesion interface, they can raise the accuracy of measurement.

[0013]

[Example] The first example of this invention is explained with reference to drawing 1 below. In this example, the rod lens which changes from low distorted glass to the through tube 19 which is the passage part of light is inserted, and it is fixing with adhesives 20. Generating of the birefringence of light can be suppressed very low by inserting in a through tube 19 what low distorted glass is the optical glass from which internal residual stress was removed by selection and annealing processing of a material, and used this low distorted glass for the rod lens. Furthermore, since a rod lens is the object which the lens and the glass rod unified, in optical-axis association with the capillary tube section 22, it becomes possible [carrying out good optical coupling to the core wire 23 of an optical fiber with a condensing operation], and also it has high proof stress to vibration or an impact.

[0014] Young's modulus as an adhesion means between this rod lens and the optical airtight connector 8 0.05 - 100kg/mm² Since an impact, vibration, thermal stress, etc. are absorbable with that elasticity if the adhesives of silicone rubber are used, precision can be improved further. However, silicone rubber is SF6. Since a degradation rate will increase if it deteriorates by HF component and oxygen in gas and is exposed to ultraviolet rays, it is necessary by covering an outside surface by protection material to maintain a property.

[0015] Moreover, an opto elastic constant as other examples If what inserted the optical fiber which are below $1.0 \times 10^{-9} \text{cm}^2 / \text{kg}$, and the so-called low distorted optical fiber in the through tube 19 which is the passage part of light, and carried out adhesion immobilization is used, the induction of the birefringence produced to stress can be reduced. With the fiber made from a quartz, this opto elastic constant as an optical fiber generally used For a certain reason, $340 \times 10^{-9} \text{cm}^2 / \text{kg}$ extent of reduction of the induction of the birefringence in this example is also remarkable. Furthermore, Young's modulus also in the adhesion means between this low distorted optical fiber and the optical airtight connector 8 0.05 - 100kg/mm² If the adhesives of silicone rubber are used, since an impact, vibration, thermal stress, etc. are absorbable, precision can be raised further. In addition, since it is conventionally the same as a formal optical airtight connector, the concrete configuration of this example is omitted.

[0016] Now, instead of connecting a low distorted optical fiber with an optical connector 18, since a low distorted optical fiber has the small opto elastic constant and generating of a birefringence can be reduced, welding junction can be carried out with the optical fiber for the object for direct light-receiving, or light transmission, an optical path becomes simple and the problem over loss, an optical-axis gap, vibration at the time of connector coupling, etc. is lost. Furthermore, selection of adhesives 20 can be freed comparatively, and also it becomes possible to make low distorted glass and a low distorted optical fiber into multicore structure.

[0017] The example about the starting multicore structure is explained with reference to structural drawing shown in drawing 2 and drawing 3 . In case two or more optical fibers are fixed to the optical airtight connector 8, it is also possible to insert in the through tube 19 formed separately, respectively, respectively, and to carry out adhesion immobilization, but if adhesion immobilization is made insert and carried out and this sheath 27 is said to the through tube formed in the optical airtight connector 8 after it makes two or more optical fibers insert in a sheath 27 and they carry out adhesion immobilization first, a two-step immobilization system is employable.

[0018] Under the starting two-step immobilization system, even if the residual strain of smallness extent remains at the time of adhesion immobilization with a sheath 27 and two or more optical fibers, since it is small components, this is removable with heat treatment. Furthermore, in case it manufactures, it is effective in being easy to process polish etc.

[0019]

[Effect of the Invention] In this invention, by having inserted low distorted glass etc. in the through tube formed in the optical airtight connector, and having carried out adhesion immobilization using silicone rubber etc., generating and an optical-axis gap of a birefringence can be reduced, and the accuracy of

measurement can be raised. Therefore, vibration and a temperature change can measure a current with high degree of accuracy under a large environment.

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TECHNICAL FIELD

[Industrial Application] This invention relates to the optical current transformer which improved to the optical airtight connector for making a pressure septum penetrate especially an optical fiber about the so-called optical current transformer which can measure a current value using light, and its manufacture approach.

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PRIOR ART

[Description of the Prior Art] It considers as a sensor, the amperometry equipment for electric power system, i.e., the optical current transformer, using light, and it carries out **** contiguity, puts a block or optical fiber of lead glass or a quartz on a conductor, passes the light of the linearly polarized light, and makes it the principle to measure the angle of rotation of the Faraday effect produced by the field generated according to the measured current which flows to a conductor.

[0003] What used the optical fiber as the sensor as an example among the conventional optical current transformers is shown in drawing 4. The sensor 4 using an optical fiber is arranged so that a conductor 2 may be surrounded inside the GIS tank 1 which is a pressure septum. A sensor 4 is fixed to the maintenance material 5, and further, the maintenance material 5 insulates from touch-down potential with an insulating material 6, and is attached.

[0004] Moreover, transfer of the light of the optical current transformer of this structure is explained with reference to drawing 5. That is, after the light which emitted the light source of a light emitting diode 14 in the photo-electric-conversion section 9 passes an optical fiber 11, it is made into the linearly polarized light which polarized with the polarizer 12, carries out incidence to a sensor 4, obtains the fixed angle of rotation by the Faraday effect by passing the field generated around a conductor 2, and outgoing radiation is carried out to an analyzer 13, and it reaches a photodiode 15 after passing an optical fiber 11 again. Here, a condenser lens 17 is for serving to extract the flux of light of the light which is attached in the both ends of an optical fiber 11, respectively, and passes through the inside of an optical fiber. Furthermore, the airtight connector 8 through an optical connector 18 is connected to an optical fiber 11, an airtight is maintained, and the internal and external gas pressure difference of the GIS tank 1 is coped with. Furthermore, the light emitting diode 14 and the photodiode 15 which constitute the photo-electric-conversion section 9 are connected to the operation output section 10, respectively, and data processing is made.

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EFFECT OF THE INVENTION

[Effect of the Invention] In this invention, by having inserted low distorted glass etc. in the through tube formed in the optical airtight connector, and having carried out adhesion immobilization using silicone rubber etc., generating and an optical-axis gap of a birefringence can be reduced, and the accuracy of measurement can be raised. Therefore, vibration and a temperature change can measure a current with high degree of accuracy under a large environment.

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TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention] As for the optical fiber used for the optical airtight connector 8, it is desirable that it is accurate so that information on light may not be disturbed. However, although amorphous solid-states like the glass generally used as Faraday effect material are directions [target / optical], if stress is applied from the exterior, it will become an anisotropy optically and a birefringence will be caused. Moreover, since a coefficient of thermal expansion generally differs from other matter when glass is being firmly fixed to other matter, the thermal stress inside the glass generated by the temperature change also causes a birefringence. The starting birefringence becomes the cause of worsening precision.

[0006] The detail of the optical airtight connector 8 is explained with reference to drawing 6 . Since the adhesion closure of the optical fiber etc. is embedded and carried out, with the thermal stress generated inside by the gas pressure difference of GIS tank inside and outside, and the temperature change even if it can pass the usual light, the birefringence of a propagation path becomes large, the propagation precision of the linearly polarized light for measurement falls, and the passage part 19 of light also becomes the cause by which an optical-axis gap of an optical connector bond part occurs, further. On the other hand, in a busy condition, it becomes the cause by which an optical-axis gap of an optical connector bond part also generates this vibration, with vibration, and the error noise by change of the quantity of light is also caused.

[0007] Then, the purpose of this invention is offering the optical current transformer with which it prevents the accuracy of measurement falling under the effect of the stress by the gas pressure difference, thermal stress, vibration, etc., and vibration and a temperature change can measure a current with high degree of accuracy also under a large environment by improving to an optical airtight connector.

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MEANS

[Means for Solving the Problem] In order to attain the above purpose, this invention as invention according to claim 1 the energization arranged in the pressure septum by which the insulating medium was enclosed -- in order to measure the energization current of a conductor -- said energization -- a conductor -- in a periphery enclosure with the optical fiber by which winding arrangement was carried out The optical airtight connector which is airtightly attached in opening prepared in said pressure septum in order to derive to the operation output section which calculates said energization current which has arranged the light which carries out light transmission of this optical fiber to said pressure septum exterior, and has a through tube inside, In a preparation ***** current transformer, the optical current transformer which insertion arrangement of the rod lens is carried out airtightly at said through tube of said optical airtight connector, and is characterized by drawing said light to said operation output section is offered.

[0009] moreover, the energization arranged as invention according to claim 2 in the pressure septum by which the insulating medium was enclosed -- in order to measure the energization current of a conductor -- said energization -- a conductor -- in a periphery enclosure with the optical fiber by which winding arrangement was carried out The optical airtight connector which is airtightly attached in opening prepared in said pressure septum in order to derive to the operation output section which calculates said energization current which has arranged the light which carries out light transmission of this optical fiber to said pressure septum exterior, and has a through tube inside, In a preparation ***** current transformer, an opto elastic constant to said through tube of said optical airtight connector Insertion arrangement of the optical fiber below $1.0 \times 10^{-9} \text{cm}^2 / \text{kg}$ is carried out airtightly, and the optical current transformer characterized by drawing said light to said operation output section is offered.

[0010] Moreover, in case said optical airtight connector is made to penetrate two or more optical fibers as invention according to claim 3 and adhesion immobilization is carried out, after inserting an optical fiber in these through tubes of the sheath in which two or more through tubes were formed and carrying out adhesion immobilization of this, the manufacture approach of the optical current transformer characterized by inserting this sheath in the through tube formed in the optical airtight connector, and carrying out adhesion immobilization of this is offered.

[0011] moreover -- as an adhesion means [in / as invention according to claim 4 / the through tube of said optical airtight connector] -- Young's modulus $0.05 - 100 \text{kg/mm}^2$ it is -- the optical current transformer according to claim 1 to 3 characterized by using the silicone rubber which covered the outside surface by protection material is offered.

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OPERATION

[Function] Under a configuration of starting, by having inserted low distorted glass etc. in the through tube formed in the optical airtight connector, and having carried out adhesion immobilization, generating and an optical-axis gap of a birefringence can be reduced, and the accuracy of measurement can be raised. Moreover, since low distorted glass, etc. an optical airtight connector, and airtight immobilization of a between use silicone rubber as adhesives and they may absorb the stress which joins an adhesion interface, they can raise the accuracy of measurement.

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EXAMPLE

[Example] The first example of this invention is explained with reference to drawing 1 below. In this example, the rod lens which changes from low distorted glass to the through tube 19 which is the passage part of light is inserted, and it is fixing with adhesives 20. Generating of the birefringence of light can be suppressed very low by inserting in a through tube 19 what low distorted glass is the optical glass from which internal residual stress was removed by selection and annealing processing of a material, and used this low distorted glass for the rod lens. Furthermore, since a rod lens is the object which the lens and the glass rod unified, in optical-axis association with the capillary tube section 22, it becomes possible [carrying out good optical coupling to the core wire 23 of an optical fiber with a condensing operation], and also it has high proof stress to vibration or an impact.

[0014] Young's modulus as an adhesion means between this rod lens and the optical airtight connector 8 0.05 - 100kg/mm² Since an impact, vibration, thermal stress, etc. are absorbable with that elasticity if the adhesives of silicone rubber are used, precision can be improved further. However, silicone rubber is SF6. Since a degradation rate will increase if it deteriorates by HF component and oxygen in gas and is exposed to ultraviolet rays, it is necessary by covering an outside surface by protection material to maintain a property.

[0015] Moreover, an opto elastic constant as other examples If what inserted the optical fiber which are below $1.0 \times 10^{-9} \text{cm}^2 / \text{kg}$, and the so-called low distorted optical fiber in the through tube 19 which is the passage part of light, and carried out adhesion immobilization is used, the induction of the birefringence produced to stress can be reduced. With the fiber made from a quartz, this opto elastic constant as an optical fiber generally used For a certain reason, $340 \times 10^{-9} \text{cm}^2 / \text{kg}$ extent of reduction of the induction of the birefringence in this example is also remarkable. Furthermore, Young's modulus also in the adhesion means between this low distorted optical fiber and the optical airtight connector 8 0.05 - 100kg/mm² If the adhesives of silicone rubber are used, since an impact, vibration, thermal stress, etc. are absorbable, precision can be raised further. In addition, since it is conventionally the same as a formal optical airtight connector, the concrete configuration of this example is omitted.

[0016] Now, instead of connecting a low distorted optical fiber with an optical connector 18, since a low distorted optical fiber has the small opto elastic constant and generating of a birefringence can be reduced, welding junction can be carried out with the optical fiber for the object for direct light-receiving, or light transmission, an optical path becomes simple and the problem over loss, an optical-axis gap, vibration at the time of connector coupling, etc. is lost. Furthermore, selection of adhesives 20 can be freed comparatively, and also it becomes possible to make low distorted glass and a low distorted optical fiber into multicore structure.

[0017] The example about the starting multicore structure is explained with reference to structural drawing shown in drawing 2 and drawing 3 . In case two or more optical fibers are fixed to the optical airtight connector 8, it is also possible to insert in the through tube 19 formed separately, respectively, respectively, and to carry out adhesion immobilization, but if adhesion immobilization is made insert and carried out and this sheath 27 is said to the through tube formed in the optical airtight connector 8 after it makes two or more optical fibers insert in a sheath 27 and they carry out adhesion immobilization

first, a two-step immobilization system is employable.

[0018] Under the starting two-step immobilization system, even if the residual strain of smallness extent remains at the time of adhesion immobilization with a sheath 27 and two or more optical fibers, since it is small components, this is removable with heat treatment. Furthermore, in case it manufactures, it is effective in being easy to process polish etc.

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] The sectional view showing the structure of an optical airtight connector of the first example of this invention.

[Drawing 2] The sectional view showing the structure at the time of making a low distorted optical fiber etc. into multicore structure in this invention.

[Drawing 3] Structural drawing showing the sheath for adopting a two-step immobilization system in this invention in case a low distorted optical fiber etc. is made into multicore structure.

[Drawing 4] The sectional view showing the structure of the common optical whole current transformer which used the optical fiber as the sensor.

[Drawing 5] The schematic diagram showing the path of the light of the common optical current transformer shown in drawing 4.

[Drawing 6] The sectional view showing the formal structure of an optical airtight connector conventionally.

[Description of Notations]

1 [-- An optical airtight connector, 10 / -- The operation output section, 11 / -- ** and the optical fiber for light-receiving, 12 / -- A polarizer, 13 / -- An analyzer, 14 / -- Light emitting diode, 15 / -- A photodiode, 19 / -- A through tube, 20 / -- Adhesives, 27 / -- A sheath, 29 / -- Rod lens] -- A GIS tank, 2 -- A conductor, 4 -- The optical fiber for sensors, 8

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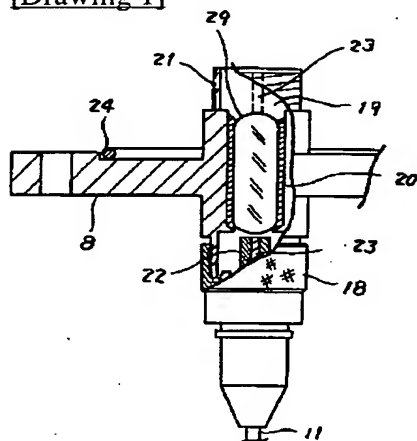
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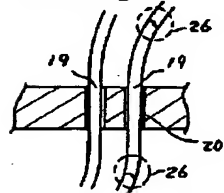
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DRAWINGS

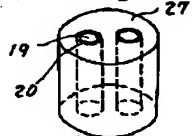
[Drawing 1]



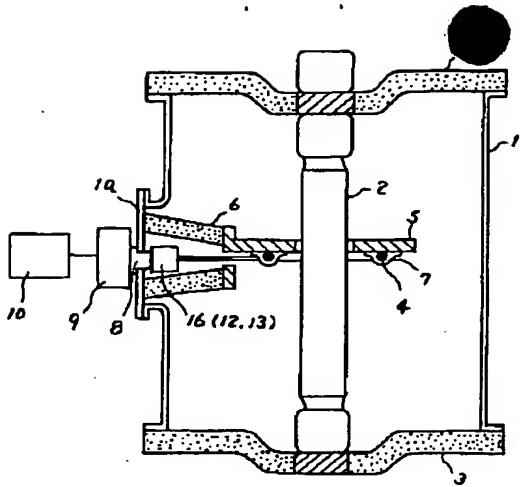
[Drawing 2]



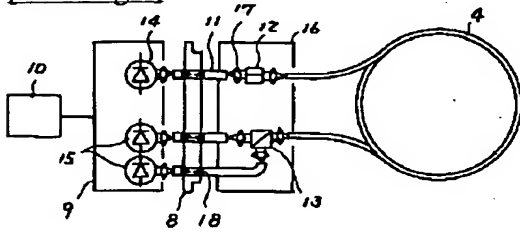
[Drawing 3]



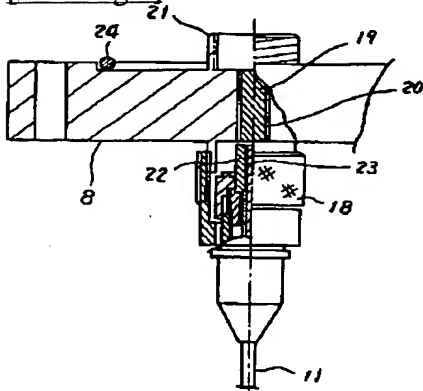
[Drawing 4]



[Drawing 5]



[Drawing 6]



[Translation done.]

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